

excellent drawings and photographs, they give a clear idea of the vigorous manner in which the work is carried on. Additional authority is given to them by the fact that they contain contributions by Mr. L. I. Seymour, Mr. C. Butters, and other leading engineering experts. The volume concludes with valuable information regarding material and supplies, labour, working costs, mine accounts, mining laws and regulations, production and dividends. A good index, eighty illustrations, fourteen photographic plates, and seven folding maps and plans, complete a volume of which the authors may justly be proud. With the exception of a geological map, which would have been a useful addition, the only omission appears to be a bibliography of the existing literature relating to the subject. The authors appear to be unacquainted with the geological work of Mr. C. J. Alford (London, 1891), and with the engineering descriptions of Mr. T. Reunert (London, 1893). Indeed they regard the published information relating to the nature of the ore deposits and to the extraction of the gold as meagre and inadequate. Yet Mr. W. Gibson in 1892 published a list of sixty-seven works on South African geology, sixteen of which bear directly upon the geology of the Transvaal. Mr. Schmeisser in 1894 gave the titles of fifty such works, and Dr. K. Futterer in 1895 gave 156 titles. With the rapid development of the mining industry, literary productions become antiquated with remarkable rapidity. When the writer of this review visited the Witwatersrand in 1892, there were 1907 stamps running. Now, according to Dr. Hatch and Mr. Chalmers, there are 2642 (June 1895). Since 1892 work has been pushed on more vigorously than ever before, and from the sixty mines near the outcrop of the main bed 5,000,000 tons of ore have been extracted in 1893 and 1894. Numerous deep boreholes have been put down to the dip of the bed, and several shafts have been sunk, encountering the auriferous conglomerates at depths of 600 to 1000 feet. Five years hence there will be 8000 stamps running. The present average stamping capacity is over four tons per stamp per day, and it is probable that, owing to technical improvements, the average will be five tons. With a total extraction of 10 dwts. of gold per ton, the output should be 6,500,000 ounces. The ore reserves are estimated at 170,000,000 tons, equal at 45s. per ton to £382,000,000. It seems unlikely that the average cost of mining and treating this ore will exceed the present cost of 30s. per ton. The authors think, therefore, that they may safely forecast a production from the Witwatersrand within the next half-century of £700,000,000, of which £200,000,000 will be profit.

BENNETT H. BROUGH.

STARCH.

Untersuchungen über die Stärkekörner. By Dr. A. Meyer. (Jena: Fischer, 1895.)

THOSE who are best acquainted with the laboured details of Naegeli's classical investigations into the nature and growth of starch-grains, and the controversy which followed regarding his astounding hypothesis, which so long dominated certain of our text-books under the name of the "intussusception theory," will best be prepared for another huge work of inquiry into the physical

and chemical nature, growth and solution, and significance to the plant generally of those curious structures. The full appreciation of the magnitude and value of Meyer's task will depend on the reader's acquaintance with the bearing of numerous discoveries which have been made since Naegeli's day, and turned to criticism and the final overthrow of his hypothesis; and among these stand prominently, on the biological side, Schimper's demonstration of the significance of the various plastids to the stratification of the starch-grain, Sachs' brilliant work on the rôle of the starch-grain in assimilation, and Strassburger's severe criticisms in his researches on the structure and growth of the cell-wall; and, on the physical and chemical side, Émil Fischer's work on the synthesis of carbohydrates, and the splendid work of our own countryman Horace Brown—the latter, indeed, as much physiological as chemical in its methods and results.

Meyer's book, which contains over 300 large pages of closely-printed German in the dryest of styles, which would be hard to forgive if the matter were not so good and the spirit so enthusiastic, covers the whole range of the enormous domain now centred around this formerly so insignificant a structure, the starch-grain; and it is embellished with nine tables and ninety-nine illustrations, good, bad, and indifferent, for the quality of the figures varies much, suggesting periods of different powers or methods of delineation during the fifteen years or so the author has been occupied with this monumental monograph.

For it is monumental, in the sense that it has evidently been gradually built up as a big structure, bit by bit, with morsels of hard evidence dug with great labour from the difficult quarry of facts, only to be worked with the best powers of the microscope, and the best methods which modern technique puts at the disposal of the investigator.

The work may be regarded as divided into five parts. The chemistry, physics, and biological properties of the starch-grain as an object of research, form the subject-matter of three of these parts; the fourth is occupied with some extremely ingenious and careful comparative studies of the changes undergone by the grain in the different organs of various selected plants, at stated seasons, and under experimentally varied conditions; while the fifth part may be taken as the critical survey of the investigations and views of others scattered through the body of the work, and the copious literature collected at the end.

It is, of course, impossible to traverse a work like this in a review, and the following short summary must suffice for a glimpse at Meyer's views and results, some of which he has already published in short papers from time to time.

He regards the typical starch-grain as consisting of two substances, one of which, *α-Amylose*, can be obtained separately in the crystalline form, whereas the other—*β-Amylose*—cannot be isolated in crystals. The relations of these two constituents to each other, and to other carbohydrates found in modified starch-grains, are considered in detail; they occur in the grain itself as acicular crystals (*trichites*) arranged more or less radially, and the starch-grain is in effect nothing but a complex, mixed sphere-crystal composed of radiating branch-systems of these *trichites*, in different proportions, and more crowded in the denser layers than in the softer ones.

The cases where amylo-dextrine occurs, and the relations of all these substances to other carbohydrates, their behaviour in water of various temperatures, the action of diastase, and so forth, are discussed at great length, and we are glad to see that the author has paid attention to, and, it may be added, been considerably influenced by, the valuable work of Brown, Heron, Morris and Salomon, and there are points of discussion of interest to all these workers.

Of course a view like Meyer's must depend for its validity essentially on what experimental results can be got in the way of obtaining sphere-crystals of carbohydrates like amylose under known conditions; if the author's statements regarding the crystallisation into spherites of inulin and amylo-dextrin and other bodies in a viscous matrix can be extended to the case in point—where the protoplasm of the amyloplast acts as the viscous matrix—he has certainly made out a strong case, for all the ordinary physical properties of porosity, behaviour to polarised light, swelling, and the stratification, striation, and other structural peculiarities of the starch-grain are as easily explained if the unit of structure is a *trichite* as where it is assumed to be a *micella*.

Since it is as yet impossible to artificially crystallise the amylose composing the chief part of a normal grain, into the spherical shape, however, the war of discussion will no doubt rage around this point; in the meantime, Meyer has unquestionably marshalled his facts in heavy order and made out an ingenious case, the full significance of which can only be grasped by ploughing one's way through his heavy, but, in the main, logical German.

The phenomenon of swelling has always been a crux in hypotheses regarding the structure of organised bodies. Meyer explains it as due to the *trichites* of β -Amylose—the principal constituent of the normal starch-grain—absorbing water, and themselves swelling. In other words, the water dissolves in the crystals.

It should be noted, however, that Meyer distinguishes sharply and emphatically between *Porenquellung*, where water is merely imbibed between the crystals, and *Lösungsquellung*, where the water is taken up by the crystals; and he here emphasises what may be a useful distinction in questions of imbibition. It is, of course, *Lösungsquellung* which initiates the disorganisation of the grain.

In the discussion of the question as to the growth of the starch-grain, the author points out that the latter may grow in chromoplasts, as well as chloro- and leucoplasts, and that the grain *never* impinges on the cytoplasm—it is always completely surrounded by a layer, however thin, of its plastid so long as the cell lives; he makes this seem probable, but it is impossible to prove it in some instances. In any case, the reader will find some pretty staining methods brought to bear on the point.

Of course the grain grows by apposition, and the thickness of the layer deposited depends on that of the protoplasm in contact at the place. On the whole, indeed, the laws of growth and stratification are those laid down by Schimper and Strassburger, though Meyer adds a good many facts as to the initiation and growth of both simple and compound grains, and has devised a new nomenclature and classification of the various kinds of starch-grains which, complete and exhaustive though

it appears, we confess does not seem to meet the requirements of clearness and simplicity so fully as could be desired.

One of the most ingenious chapters in the book is that on the solution of the grains in the cell, and the significance of fissures and pores for the attack of the diastatic or other solvent.

Space is not available for detailed remarks on the author's methods of examining the changes which the starch-grains undergo in the various organs of *Adoxa*, *Hordeum*, *Dieffenbachia*, *Pellionia*, *Hyacinthus*, *Oxalis*, &c., at different times of the year and under different conditions; nor to give his views on the constitution of protoplasm—which we venture to think too much of the nature of a hastily-written note, moreover not necessary to the subject, and far from convincing in the six pages (with critical sentences on everybody from Naegeli and Wiesner to Bütschli interspersed) devoted to it. Put briefly, Meyer regards protoplasm as a peculiar emulsion, and therein agrees essentially with Berthold; whereas the elements of cell-walls and starch-grains are as truly crystallised out as is calcium oxalate.

The experiments showing that the position of the layers of the starch-grains can be altered by changing the position of the organ in which they are growing, and that the alternation of day and night is expressed in the thickness and density of the layers—that the layers are “diurnal layers”—in effect (pp. 268–271) are well worth attention, however, as indeed are very many others of the difficult experimental points brought out towards the end of the book.

That the questions centering around the starch-grain have not reached finality, is obvious, but that Meyer has contributed a valuable attempt to set some of them at rest, must be admitted by all who read his monograph. It bristles with debatable points, and there are some annoying faults—e.g. the frequent references to figures and titles in the text without sufficient clues, and to chapters ahead of the reader; but that does not weaken the fact that his results stimulate the reader to some close thinking, and his critical compilation of the history and literature of the subject alone makes the book necessary to all working botanists.

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APPLIED METEOROLOGY.

Weather and Disease. A Curve History of their Variations in Recent Years. By Alex. B. MacDowall, M.A., F.R.Met.S. (London: The Graphotone Co., 1895.)

THE systematic study of climatic conditions in connection with the fluctuation in the public health, is one which has only recently been undertaken, but which already promises results of a most interesting and important character. Apart from the inherent interest of the subject, which must indeed be apparent; the study offers, like observations in phenology, the prospect of great practical value. The work of weather forecasting is at present so wanting in accuracy, and there is so little promise of progress in this direction, that practical meteorologists might be tempted to despair, and the general public be led to imagine that the vast stores of records which have been accumulated were destined to